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Identification of suitable dye(s) among commonly used food, fabric and indicator dyes for dyeing of *Craspedia globosa* flowers

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Abstract
The lab experiment on dyeing of flowers was carried out in Factorial Completely Randomized Design (FCRD) having 22 treatment combinations with 3 replications. The flowers were dyed with 11 different types of dyes *viz*., Apple Green (D_1), Raspberry Red (D_2), Orange Red (D_3), Violet (D_4), Dark Green (D_5), Pink (D_6), Brilliant Green (D_7), Crystal Violet (D_8), Methylene Blue (D_9), Rhodamine (D_{10}), Eosin Yellow (D_{11}) dyed with 2 different solutions *viz*., dye solution in water (T_1) and dye solution with alum as a mordanting agent (T_2). The results revealed that highest score for light fastness property (4.20) was observed in the flowers dyed with indicator dye Brilliant Green (D_7). Food dye Raspberry Red (D_2) got highest points for rubbing fastness property (4.67), however food dye Apple Green (D_1) scored highest points for wash fastness property (4.42). Flowers dyed with dye solutions containing Alum scored highest points for light (3.75) and rubbing fastness properties (3.45). Maximum points for keeping quality (8.01) were scored by flowers dyed with Brilliant Green indicator dye. Flowers dyed with dye solutions containing alum as a mordanting agent scored highest points (7.75) for keeping quality.

Keywords: Identification, suitable, commonly, food, fabric, *Craspedia globosa*

Introduction
Craspedia globosa also known as Billy button belongs to Asteraceae family. They are known for their ball shaped flowers borne atop slim unbranched stems. *Craspedia* flowers are bright yellow in colour, its flowers have good attributes for value addition. Among different methods used for value addition, dyeing is one of the methods which increases the value of the product. Two main types of dyes used are Natural dyes (extracted from natural ingredients) and Synthetic dyes (made in laboratory). Alum can also be added to the dye solutions because alum acts as a mordant which improves the fastness properties such as rubbing, light and washing fastness of the dyes (Visalakshi, 2013) [1]. Three methods for dyeing of fresh flowers are absorption, dusting and dipping (Tampion and Reynolds, 1971) [2].
Global dry flower market is growing at an amazing pace of 8-10%, which provides opportunities for Indian entrepreneurs to grow their business in the global floriculture market (Singh, 2009) [3]. It is the need of the hour to standardize techniques for producing value added products. However, due to lack of work done for dyeing of *Craspedia globosa*. The research study was implemented with aim to find the most suitable dye among food, fabric and indicator dyes for dyeing of *Craspedia globosa*.

Material and Methods
The research work was carried out in the Floral Craft Laboratory of Department of Floriculture and Landscape Architecture, College of Horticulture, Dr. YS Parmar University of Horticulture and Forestry, Solan (H.P.) during the year 2021- 2022.
Craspedia flowers were dyed using 11 different dyes of various groups i.e., food dyes, fabric dyes and indicator dyes at 0.1%, 0.3% and 0.1% concentration, respectively. Food dyes included Apple Green, Raspberry Red and Orange Red while violet, dark green and pink under fabric dyes and indicator dyes consisted of Brilliant Green, Crystal Violet, Methylene Blue, Rhodamine and Eosin Yellow. Using these 11 different dyes, *Craspedia* flowers were dyed in two solutions, first solution (T_1) was prepared by adding the dyes to the boiling water at their respective concentrations and another solution (T_2) was prepared by adding alum (0.1%) to the dye solutions. The experiment was designed according to Completely Randomized Design Factorial with 3 replications and consisted of 22 treatment combinations.

Craspedia flowers were dipped in the solution for 30-60 seconds until complete colour was taken up by the flowers and then flowers were shade dried on blotting papers. After drying of flowers, observations recorded were Change in colour, Light fastness, Rubbing fastness, Wash fastness and Shelf life. For evaluating shelf life of dyed flowers, scoring out of 10 was given to flowers for their keeping quality at 4 intervals i.e., S_1 (0 day), S_2 (30 days after storage), S_3 (60 days after storage) and S_4 (90 days after storage).

Results and Discussion

Flower colour of *Craspedia* as recorded by the colour chart of Royal Horticulture Society, London was 9(1)A Yellow colour. As it can be observed from Table 1 that when alum was added to the dye solution deep colour was obtained on the flowers as compared to the ones dyed in the solutions containing water and dyes. Similar results were observed by (Annapoorani *et al.*, 2013) [4]. In case of some treatments off type colours were produced by the flowers, for eg: flowers dyed with pink fabric dye produced red purple colour and the flowers dyed with Methylene Blue indicator dye produced green colour. These changes might be due to the reaction of dyes with the natural colour of the flowers.

Flowers were exposed to direct sunlight for 4 hours and then scoring was done after evaluating them, maximum points were given to the flowers which had undergone least fading and vice versa (Scoring out of 5). Least fading in colour was observed in Brilliant Green indicator dye (D_7) (4.20) and flowers dyed with the solutions containing alum as a mordant scored more points (3.75). Adding mordant such as alum to the dye solution improves the contact between plant material and dye (Joyce, 1998) [5]. Results obtained are shown in Fig.1.

For evaluating rubbing fastness of dyed flowers, flowers were rubbed on white sheet of paper, flowers which produced least impression of dye on the sheet of paper were given the maximum score and vice versa (Scoring out of 5). Results obtained for rubbing fastness of dyed flowers can be observed in Fig. 2 which shows that maximum points for rubbing fastness were obtained by Food dye Raspberry Red (4.67) and the flowers dyed with solutions containing alum as a mordanting agent scored maximum points (3.45) as compared to the flowers dyed with solutions containing water and dyes only.

For evaluating the wash fastness property of flowers dyed with various dyes, flowers were held between the wet thumb and index finger for about 20 seconds and then the impression from the thumb was taken on the white sheet of paper. Samples which produced the least thumb impression were given the highest score and vice versa (Scoring out of 5). Results produced from the wash fastness property can be observed in Fig. 2, it shows that maximum score for wash fastness property (4.42) was observed by Apple Green food dye because it produced least impression of thumb on the sheet of paper.

For evaluating the shelf life of flowers after dyeing, flowers were kept in transparent cellophane bags. Observations were recorded every 30 days starting from day 0 (S_1) Today 90 (S_4). It can be observed from Fig. 4 and Table 2 that maximum score for keeping quality (8.01) evaluated after 90 days was obtained by dye D_7 i.e., Brilliant Green, minimum score (6.48) was obtained by dye D_2 i.e., Raspberry Red. In case of comparison between flowers dyed with mordanting solutions and without mordanting solutions, it was observed that maximum score i.e. (7.75) was observed with solution T_2 i.e., flowers dyed in solution containing alum (0.1%). Maximum score for keeping quality (9.50) was observed on the day of storage i.e., 0 day but as the duration was increased keeping quality of the flowers started decreasing and least score for keeping quality (5.69) was obtained in S_4 i.e., 90 days after storage.

Best results were obtained on day of dyeing of flowers but as the time passed by the quality of the flowers decreased with time, this might be due to the impact of light in storage conditions. Similar results were obtained by Sharma (2015) [6] who also obtained similar results for duration of storage in *Ornithogalum thyrsoides* Jacq.

Table 1: Changes in the flower colour after dyeing with different dyes

Sr. No.	Dyes	Without Alum (T_1)	With Alum (T_2)
1	Apple Green (D_1)	1A Yellow Green Group	154A Yellow Green Group
2	Raspberry Red (D_2)	24A Orange Red Group	33A Orange Red Group
3	Orange Red (D_3)	24A Orange Group	25A Orange Group
4	Violet (D_4)	79A Purple Group	83A Purple Group
5	Dark Green (D_5)	133A Green Group	136A Green Group
6	Pink (D_6)	59A Red Purple Group	60A Red Purple Group
7	Brilliant Green (D_7)	131B Dark Green Group	131A Dark Green Group
8	Crystal Violet (D_8)	89A Violet Blue Group	89B Violet Blue Group
9	Methylene Blue (D_9)	133A Green Group	135A Green Group
10	Rhodamine (D_{10})	42A Red Group	45A Red Group
11	Eosin Yellow (D_{11})	28A Orange Group	30A Orange Red Group

Table 2: Effect of different storage durations on shelf life of dyed *Craspedia* flowers (Scoring out of 10)

Dyes	S_1			S_2			S_3			S_4			D×T		M
	T_1	T_2	D×S	T_1	T_2	D×S	T_1	T_2	D×S	T_1	T_2	D×S	T_1	T_2	
D_1	9.50	9.50	9.50	7.60	8.20	7.90	6.30	7.50	6.90	5.10	6.90	6.00	7.12	8.02	7.57
D_2	9.50	9.50	9.50	6.00	6.80	6.40	5.00	6.00	5.50	3.70	5.30	4.50	6.05	6.90	6.48
D_3	9.50	9.50	9.50	7.40	8.10	7.75	6.10	7.40	6.75	4.90	6.70	5.80	6.97	7.92	7.45
D_4	9.50	9.50	9.50	6.60	7.30	6.95	5.40	6.60	6.00	4.20	5.90	5.05	6.42	7.32	6.87
D_5	9.50	9.50	9.50	7.20	7.90	7.55	5.90	7.20	6.55	4.70	6.50	5.60	6.82	7.77	7.30
D_6	9.50	9.50	9.50	7.80	8.40	8.10	6.40	7.70	7.05	5.30	7.10	6.20	7.25	8.17	7.71
D_7	9.50	9.50	9.50	8.10	8.90	8.50	6.80	8.10	7.45	5.70	7.50	6.60	7.52	8.50	8.01
D_8	9.50	9.50	9.50	6.80	7.50	7.15	5.60	6.80	6.20	4.40	6.10	5.25	6.57	7.47	7.02

D_9	9.50	9.50	9.50	7.00	7.70	7.35	5.70	7.00	6.35	4.50	6.30	5.40	6.67	7.62	7.15
D_{10}	9.50	9.50	9.50	8.00	8.70	8.35	6.60	7.90	7.25	5.50	7.30	6.40	7.40	8.35	7.88
D_{11}	9.50	9.50	9.50	6.40	7.10	6.75	5.20	6.40	5.80	4.00	5.70	4.85	6.27	7.17	6.72
T×S	9.50	9.50	9.50	7.17	7.87	7.52	5.91	7.15	6.53	4.73	6.48	5.69	6.82	7.75	

$CD_{0.05}$ for:
Storage Duration (S): 0.03
Mordant Solution (T): 0.02
Dyes (D): 0.05
S×T: 0.04
S×D: 0.11
T×D: NS
S×T×D: NS

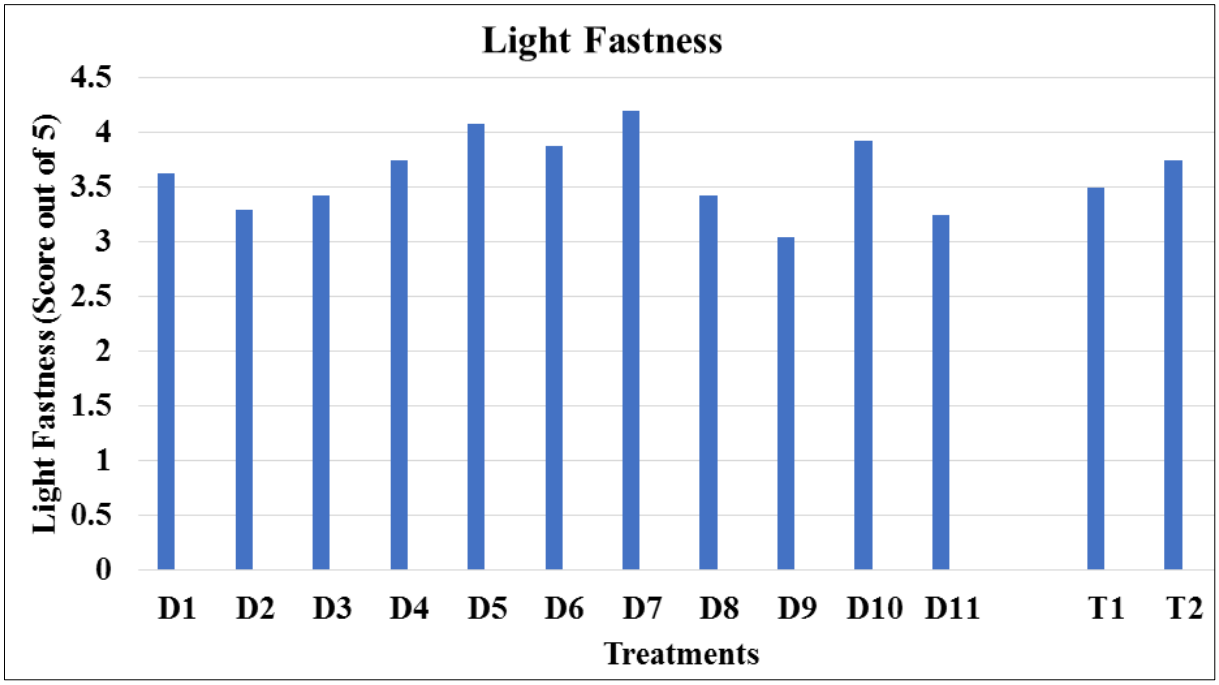

Fig 1: Effect of various dyes and mordant on light fastness properties in *Craspedia globosa* (Scoring out of 5)

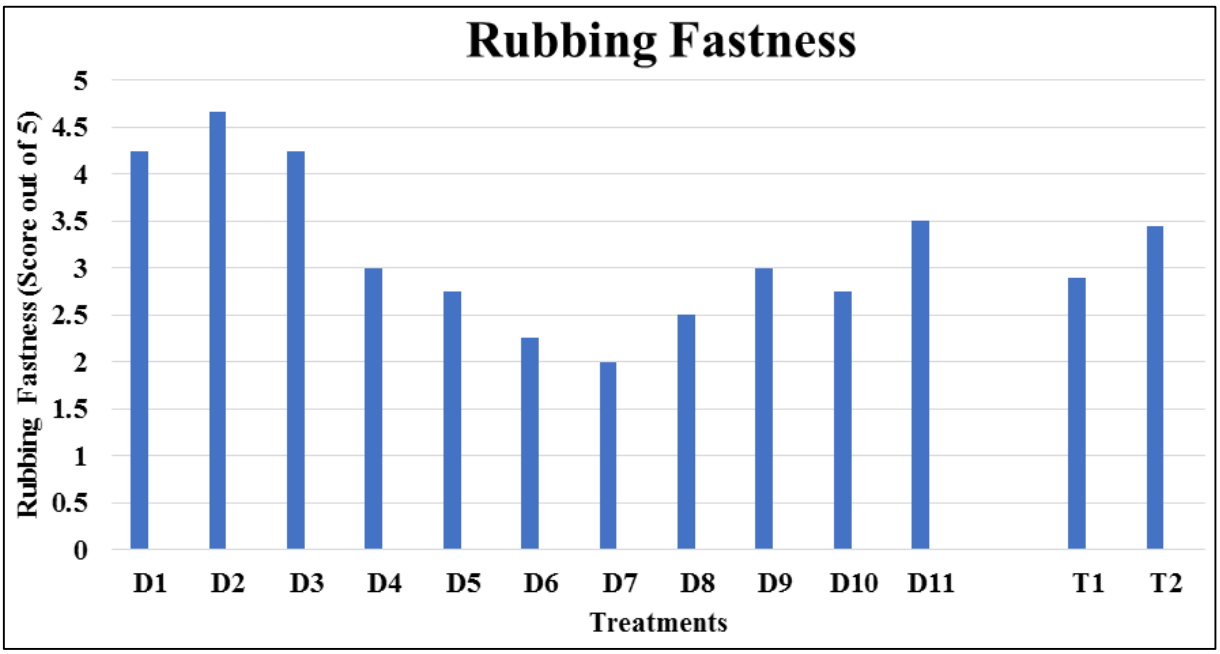

Fig 2: Effect of various dyes and mordant on rubbing fastness properties in *Craspedia globosa* (Scoring out of 5)

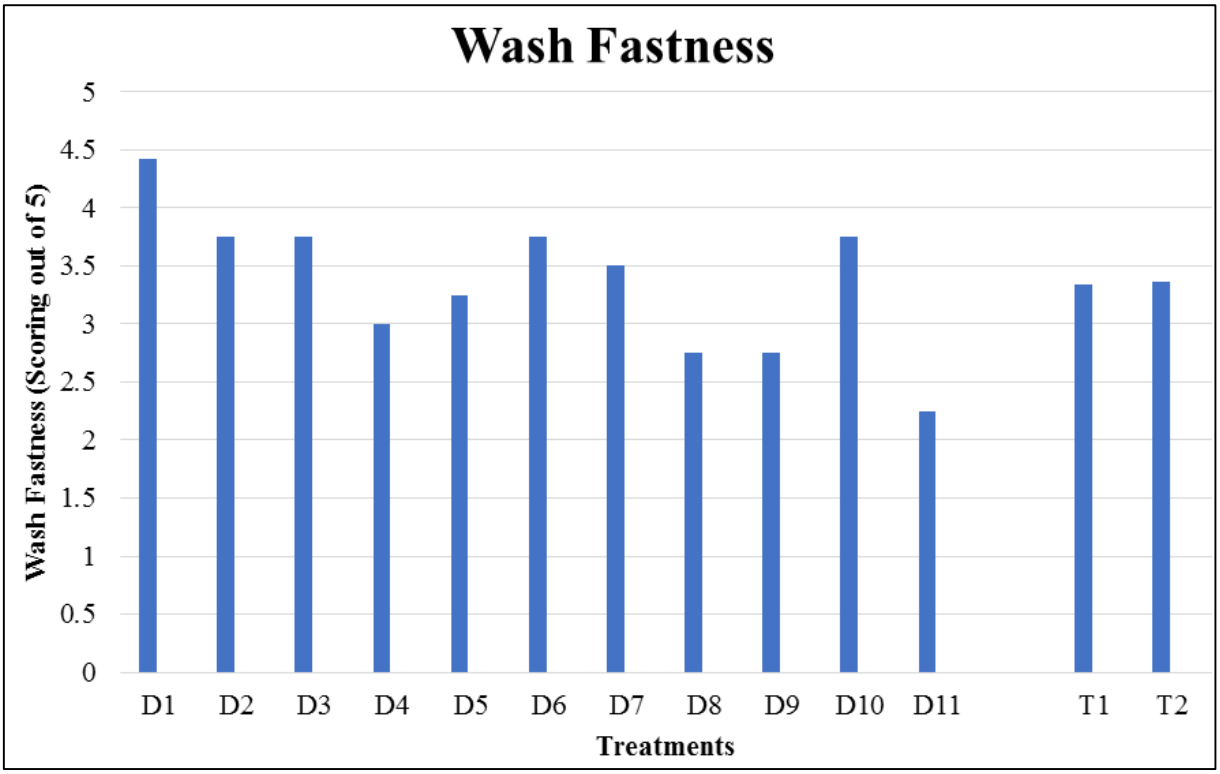

Fig 3: Effect of various dyes and mordant on wash fastness properties in *Craspedia globosa* (Scoring out of 5)

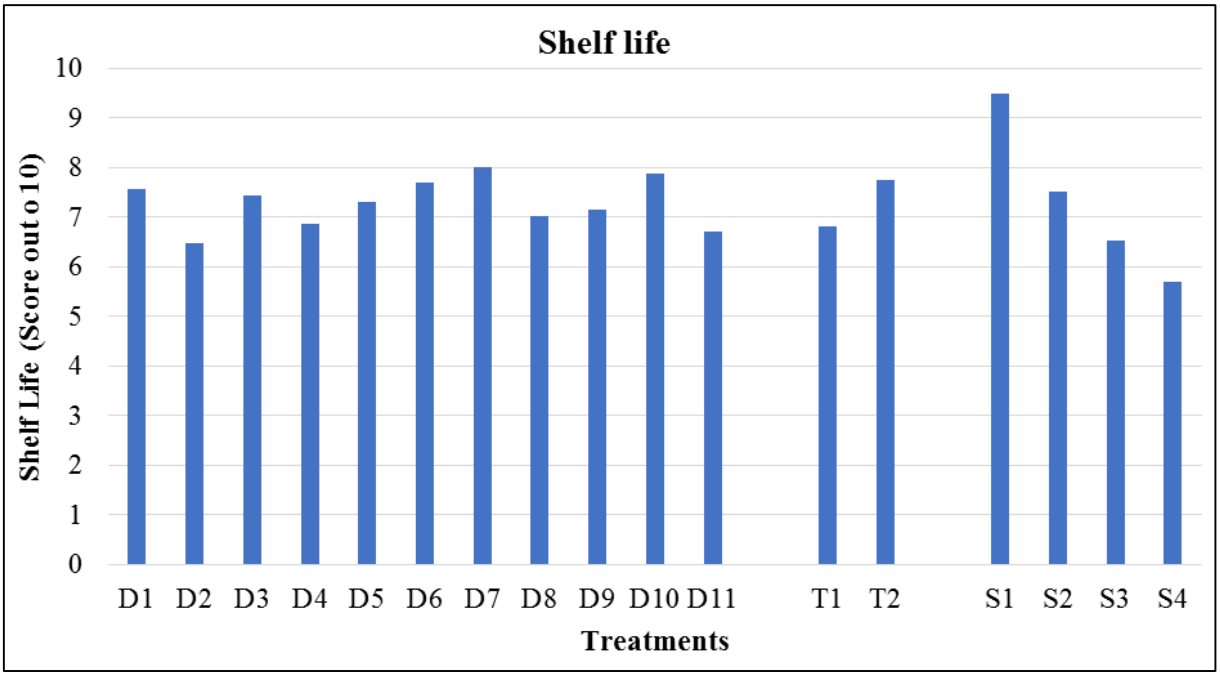

Fig 4: Effect of different storage durations on shelf life of dyed Craspedia flowers (Scoring out of 10)

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